THERMAL ENERGY STORAGE FOR COMFORT COOLING

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LEED* AP

PRESENTATION OUTLINE

- Introduction to Thermal Storage
  - -Brief Overview
  - -Typical Applications
- Why Use Thermal Storage?
  - -LEED
  - -Codes
  - -Economics/Rates
- Thermal Storage Myths
  - -Uncommon
  - -Controls
  - -First Cost Perception
  - -Redundancy Perception
- University of Arizona – TES & Self Generation

Introduction to Thermal Energy Storage

BASIC OVERVIEW

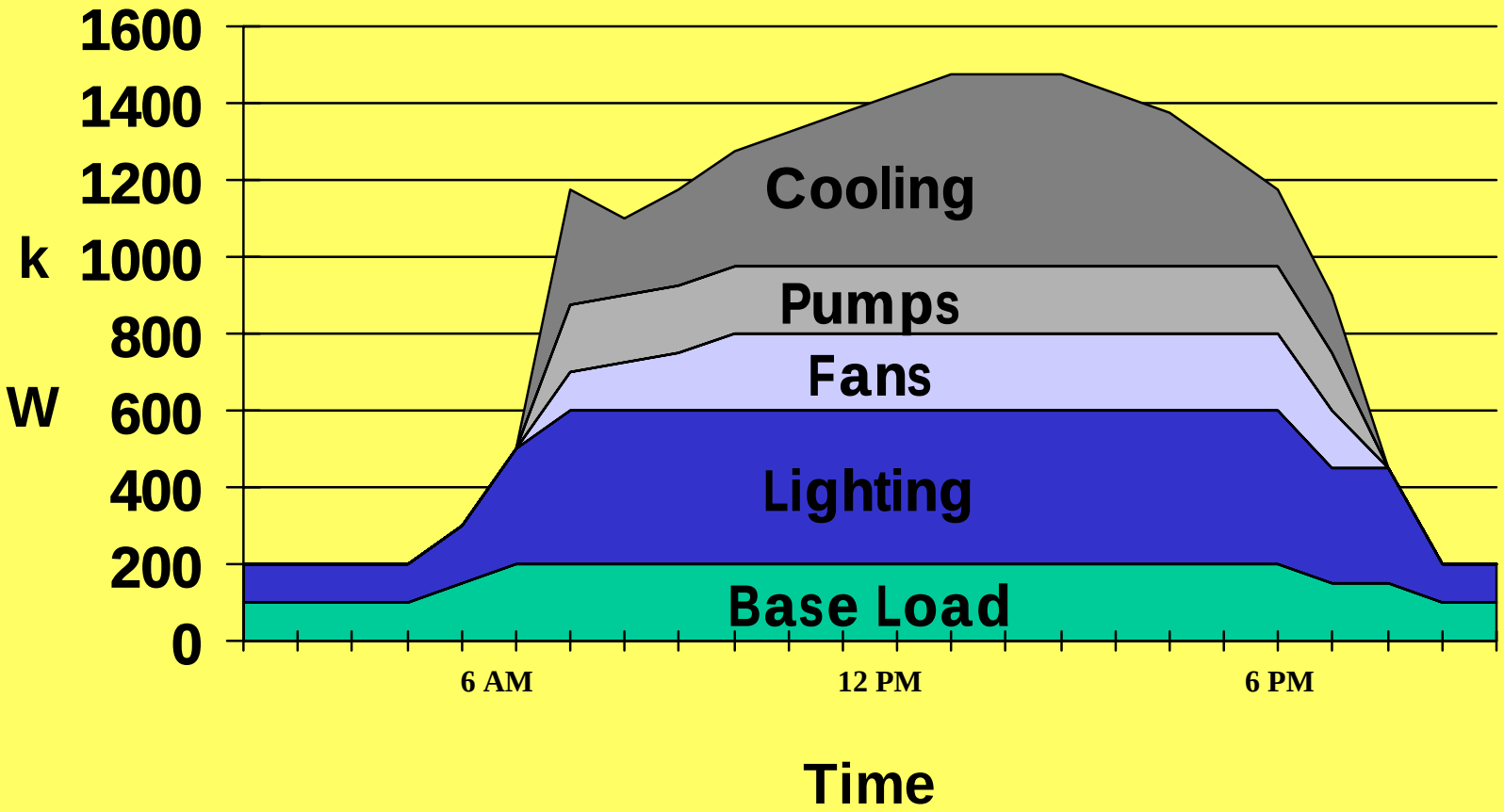
TYPICAL APPLICATIONS

Thermal Storage

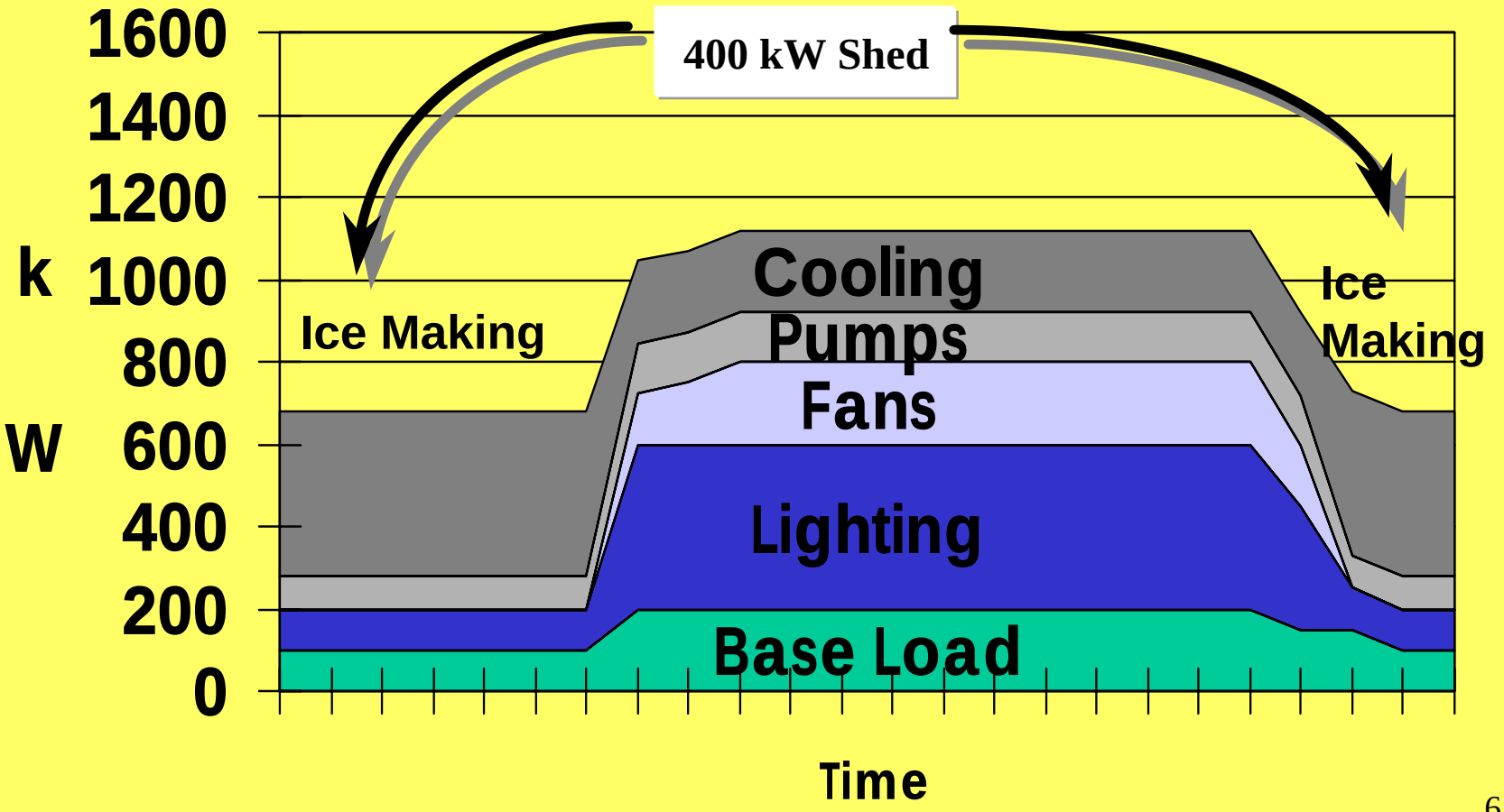
- Thermal storage systems remove heat from or add heat to a storage medium for use at another time.

- For ice-based systems, this means using a chiller to produce ice during the night when rates are lower and using the ice for cooling during the peak periods.

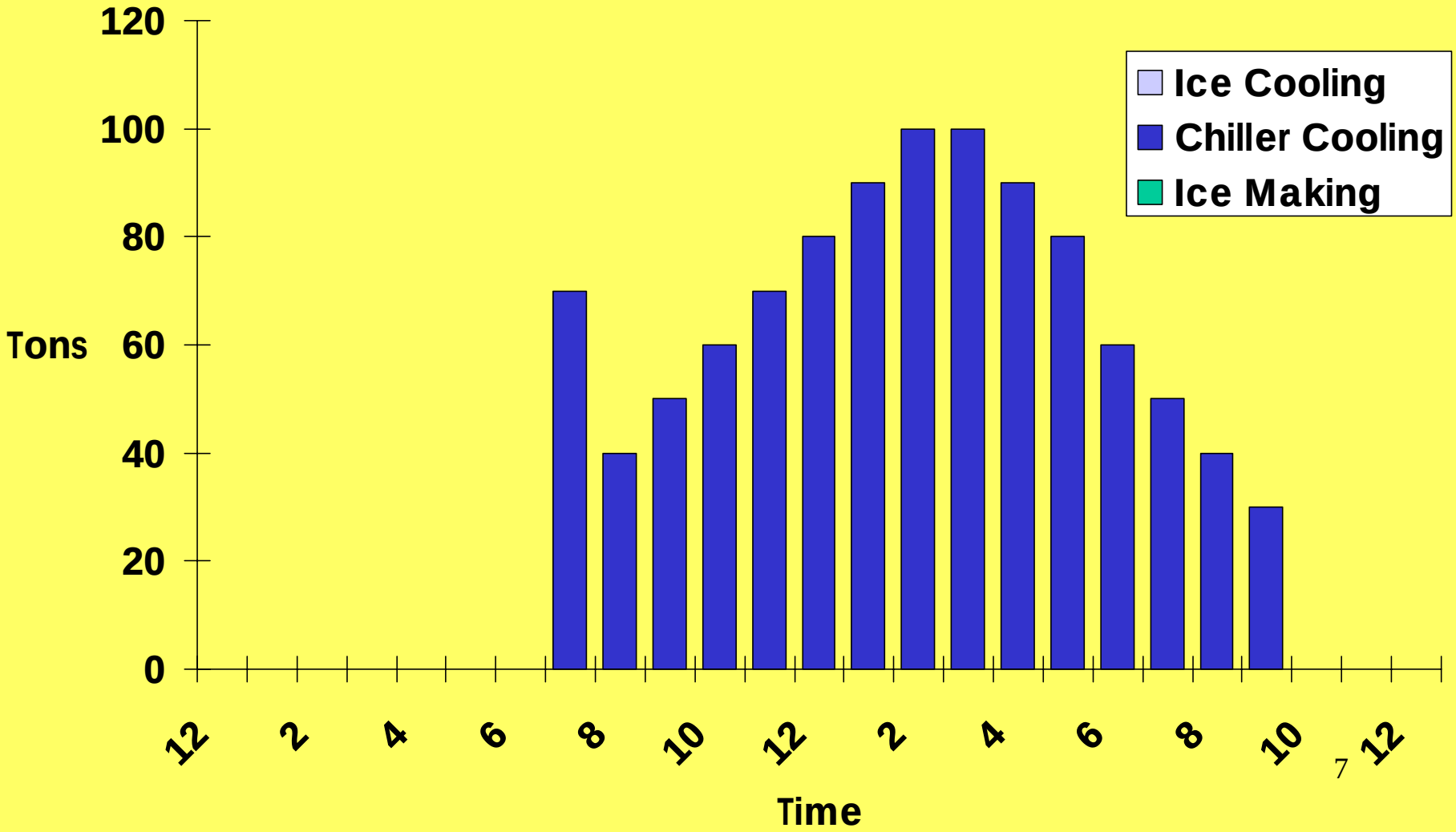
Conventional Electrical Profile



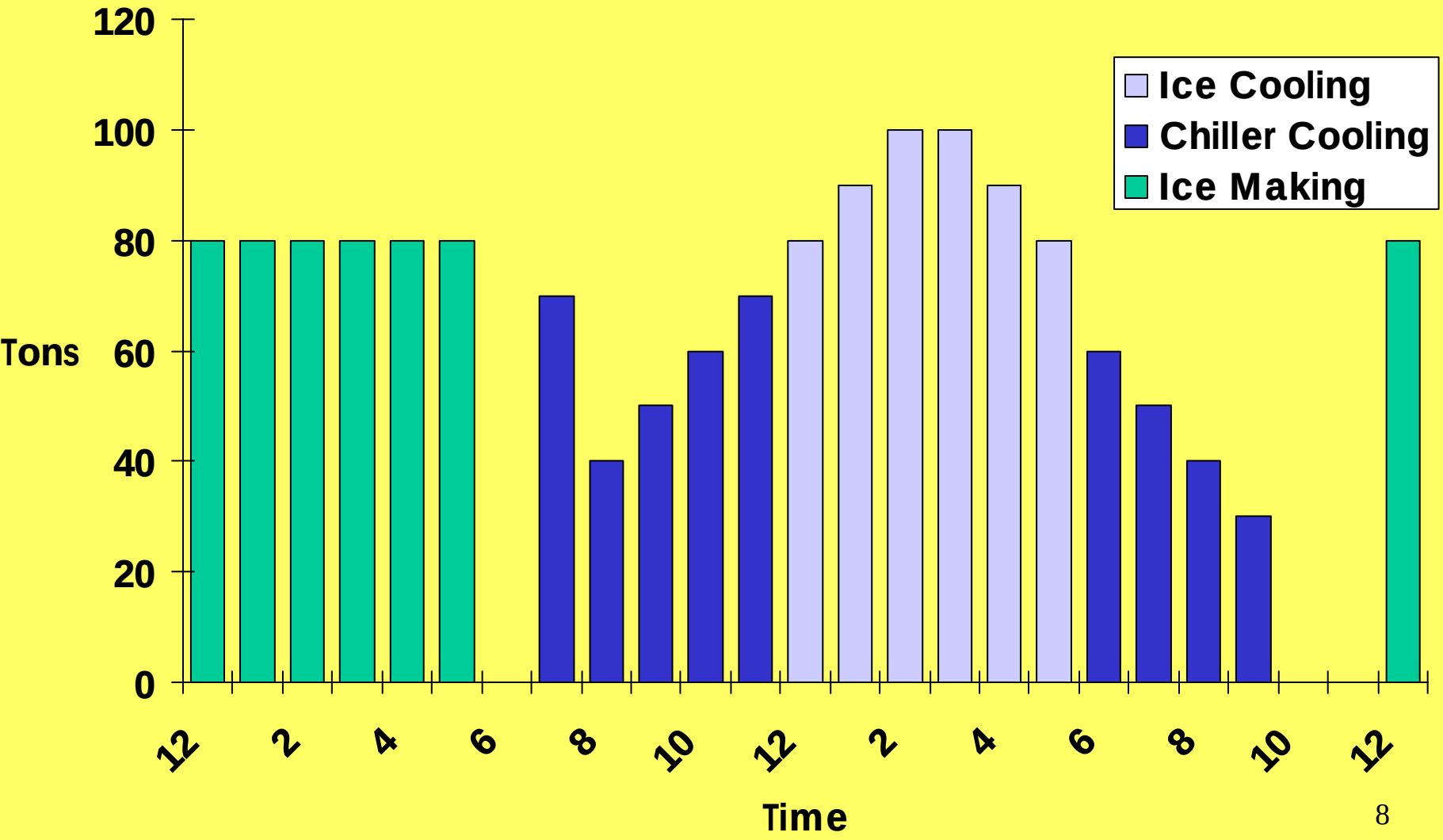
Off Peak Cooling Electrical Profile



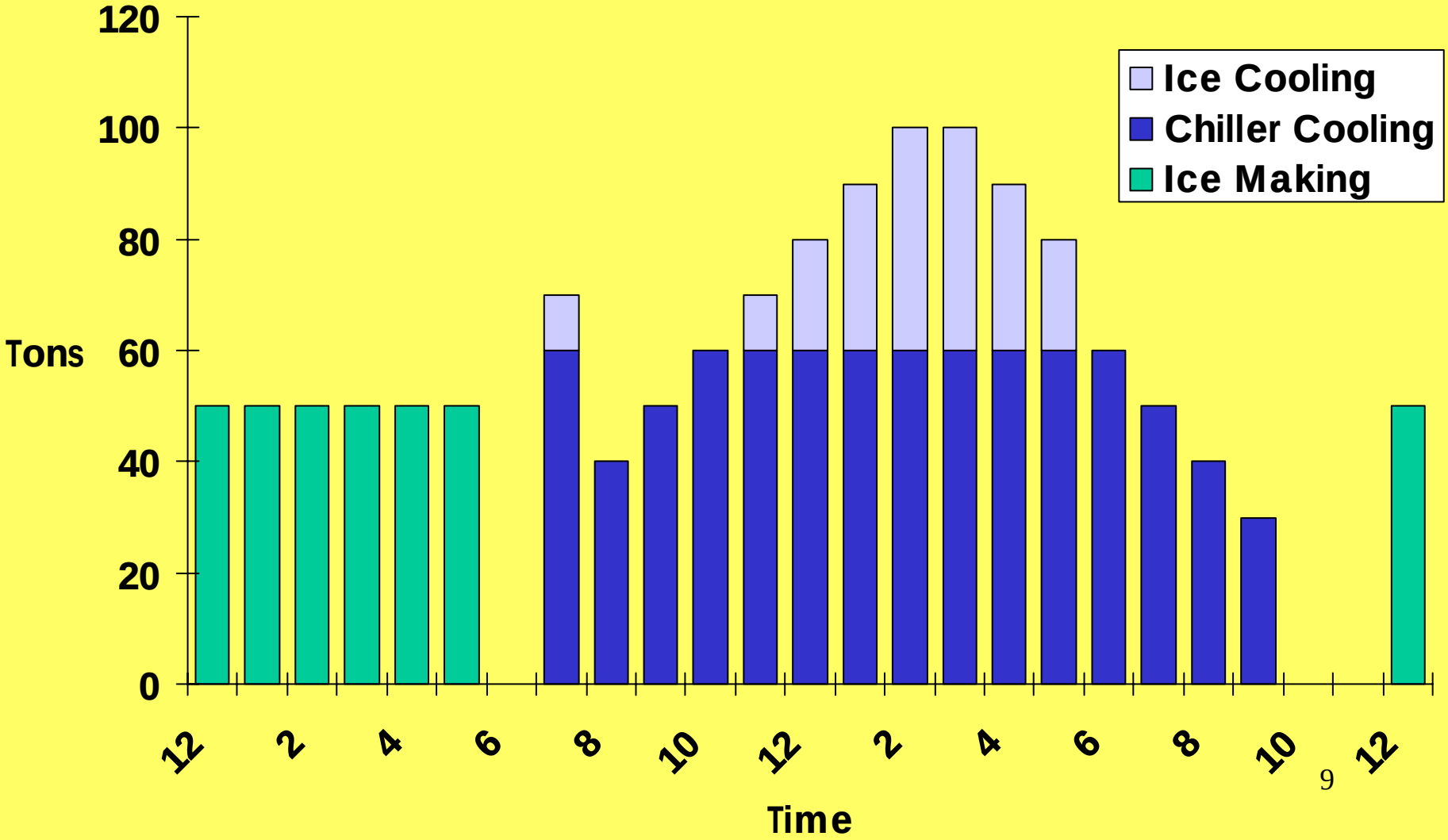
Building Cooling Profile



Full Storage



Partial Storage

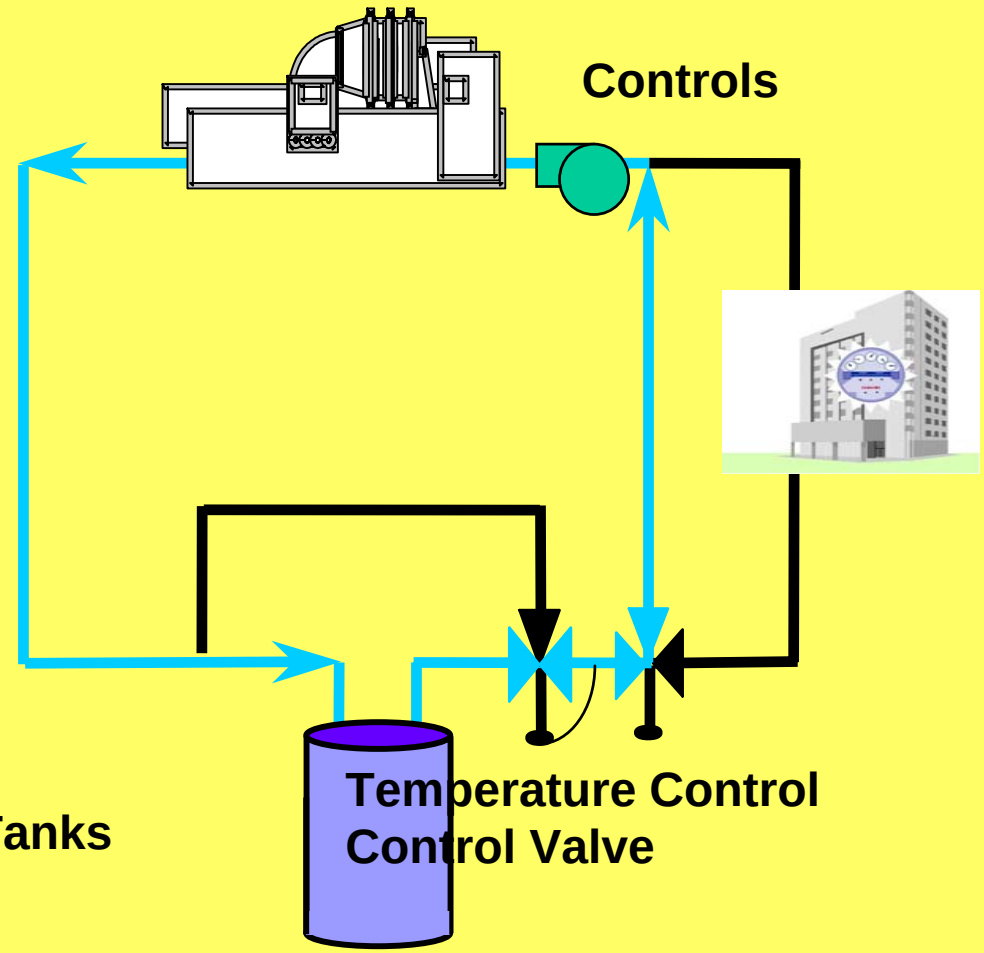


What's So Different?

25% EG/H20

Chiller Based System
- Standard Design
- No Refrigeration Piping
- No harvest cycles

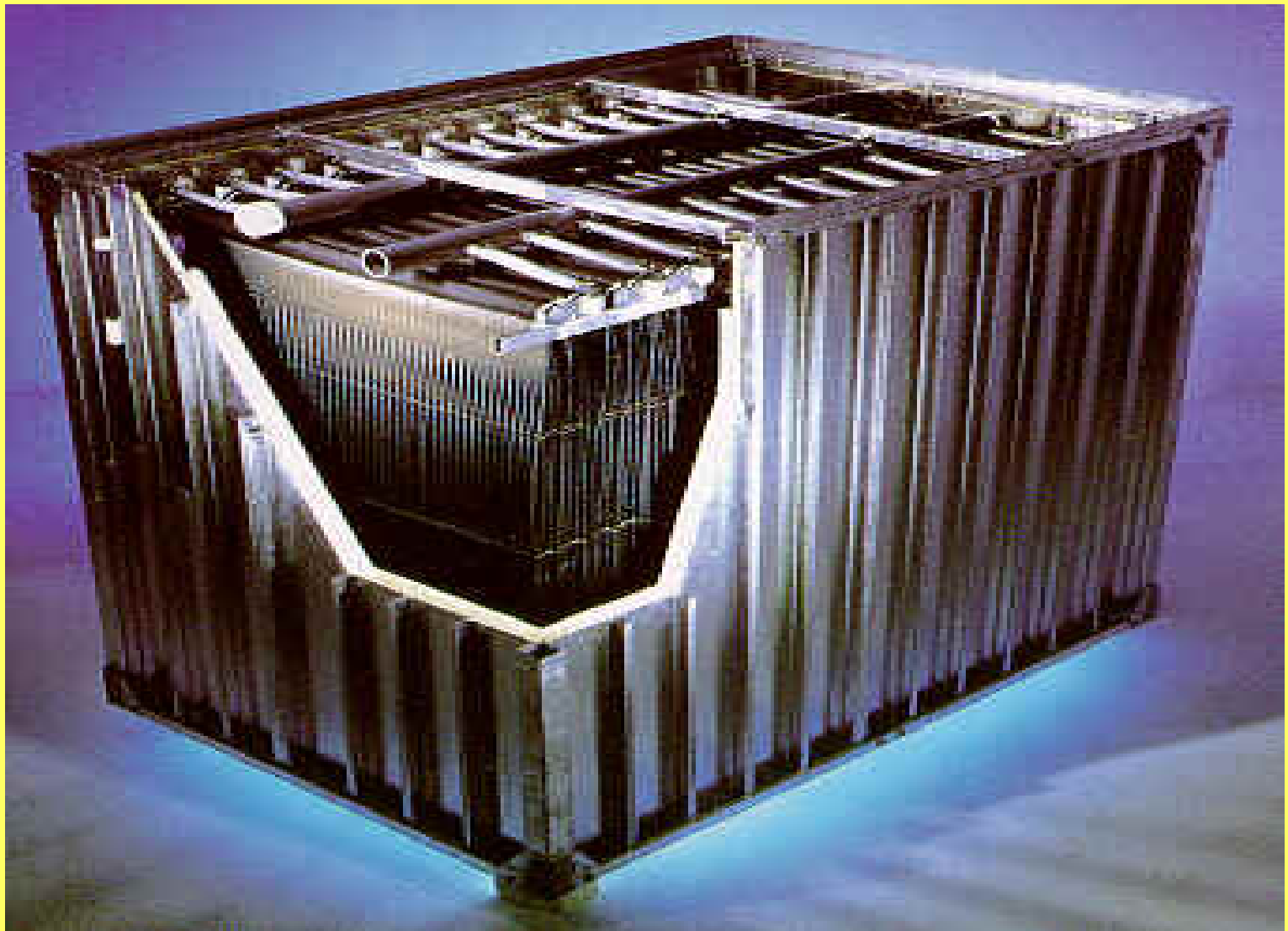
Closed System



ICE STORAGE & WATER STORAGE

- BOTH TYPES ARE COMMON AND SIMILAR
- ICE STORAGE REQUIRES CHILLERS TO OPERATE AT LOWER TEMPERATURES TO MAKE ICE
- SO WHAT'S THE MOST SIGNIFICANT DIFFERENCE?
- VOLUME ("LATENT HEAT" vs. "SENSIBLE HEAT")

- METAL TANKS, INTERNAL TUBING



ROUND POLYETHYLENE TANKS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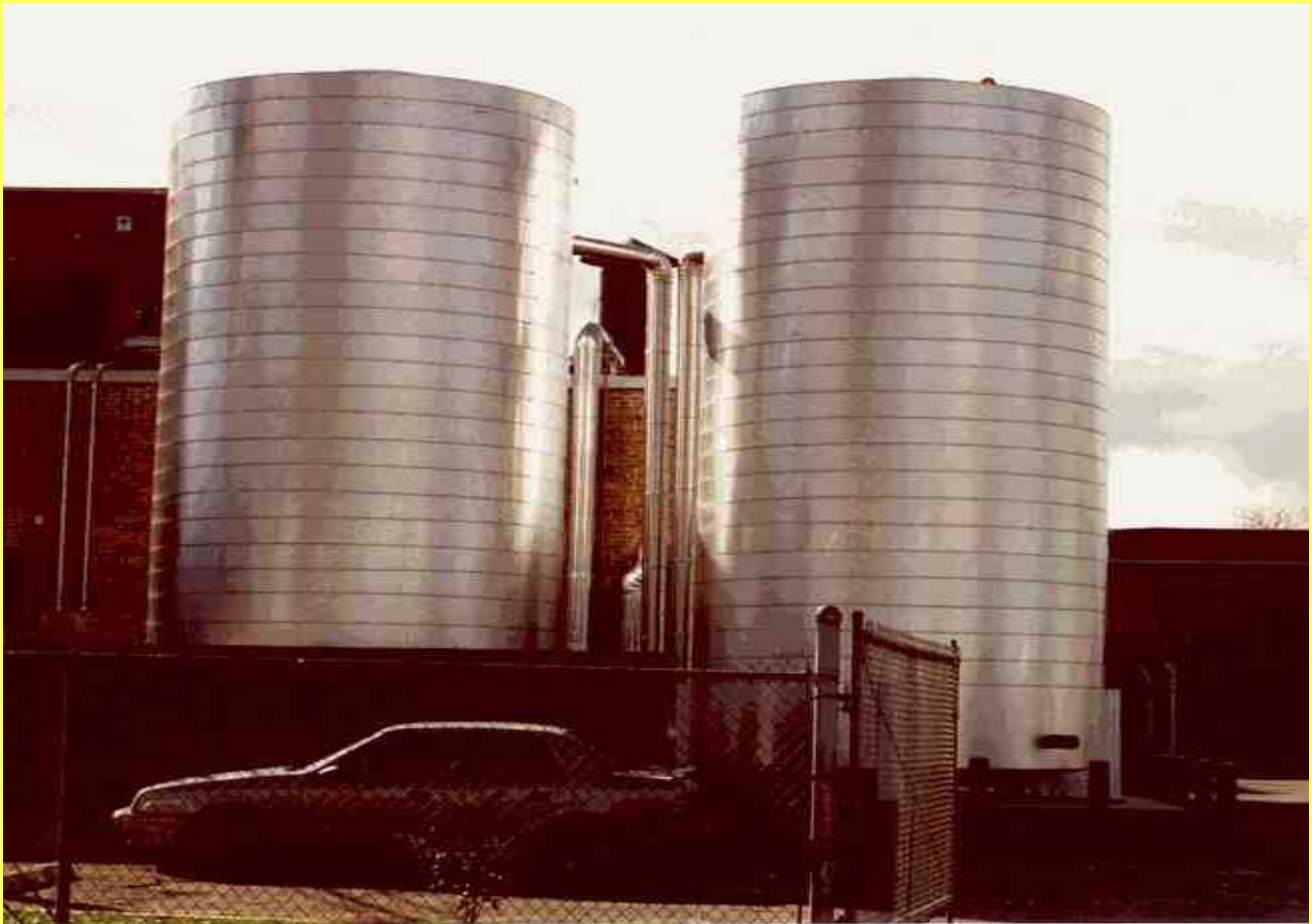
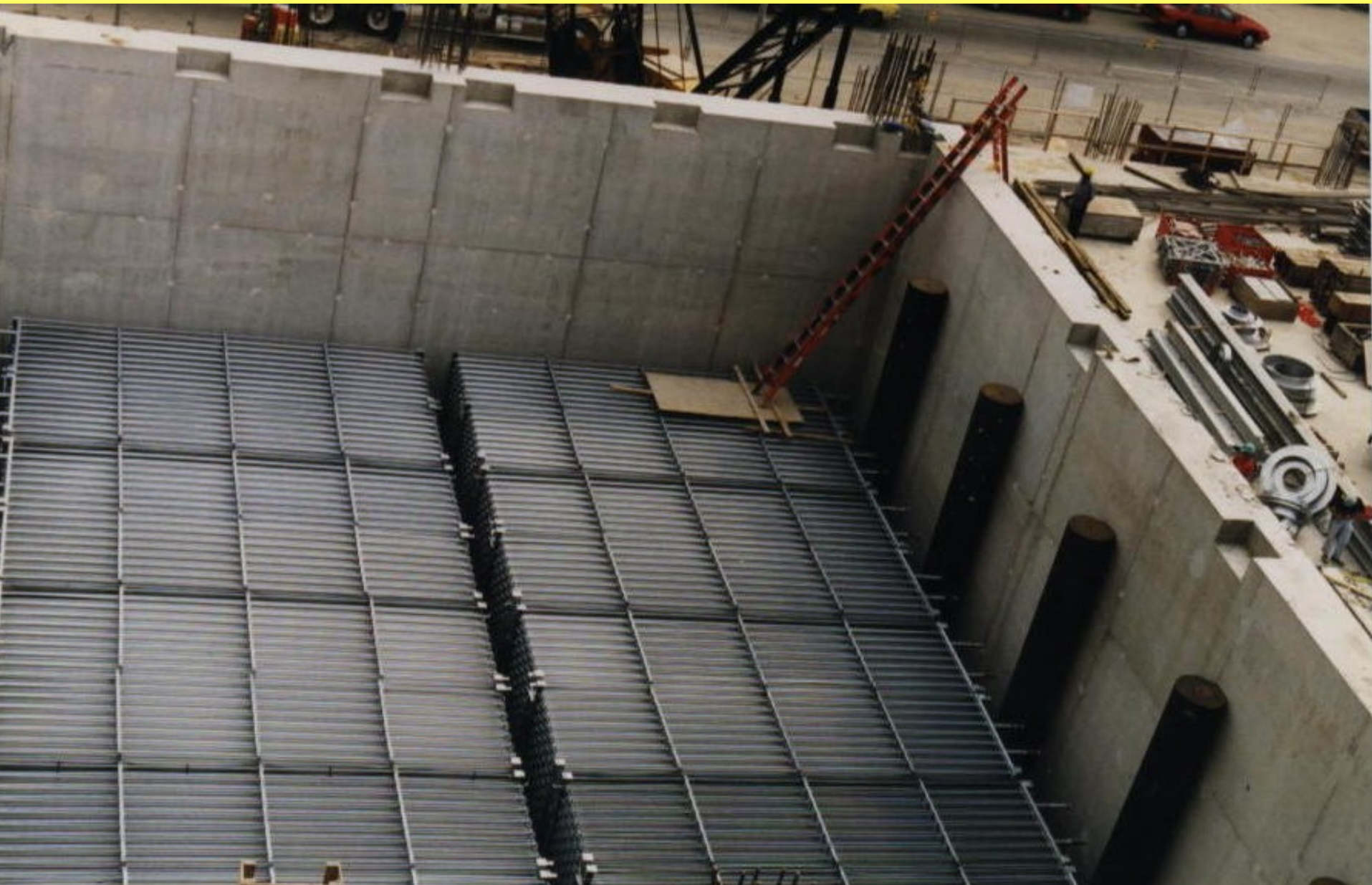
ICE BALLS, CUSTOM BUILT TANKS



METAL COILS IN A “VAULT”



Off Peak Cooling Applications

- Schools & Universities
- Churches
- Military Bases
- Offices
- Retail Stores
- Chiller Replacements
- Remodels & Additions
- Theaters
- Arenas
- Auditoriums
- Hospitals/Medical Off.
- Convention Centers

WHY USE THERMAL ENERGY STORAGE?

- LEED
- CODES (ASHRAE 90.1, CA Title 24)
- ECONOMICS (Rates)
- RIGHTSIZING

LEED

Leadership in Energy and Environmental Design

U.S. Green Building Council

LEED REGISTERED PROJECTS IN AZ

- THERE ARE CURRENTLY OVER 40 PROJECTS REGISTERED ON THE USGBC WEBSITE FOR LEED CERTIFICATION IN ARIZONA

- GO TO THE USGBC WEBSITE, CLICK ON “LEED,” “REGISTERED PROJECTS” AND CLICK ON THE LINK TO “CURRENT REGISTERED PROJECTS”

Today's Green Design Goals :

LEED RATING SYSTEM

- Sustainable Site 22%
- Water Efficiency 8%
- Conserve Materials and Resources 20%
- Good Indoor Environmental Quality 23%
- Conserve Energy and Atmosphere 27%

Leadership in Energy and Environmental Design
U.S. Green Building Council

LEED™ Points Available with Off Peak Cooling

Reduce Design Energy Cost*

New Bldgs	Existing Bldgs	LEED™ Points
15%	5%	1
20%	10%	2
30%	20%	4
40%	30%	6
50%	40%	8
60%	50%	10

* **Over ASHRAE 90.1, 1999 Energy Cost Budget or local code which ever is more stringent**

CODES

- ASHRAE 90.1 – Governs Mechanical Design

- California – Title 24
- The 2005 revision has been revised to use a "TIME DEPENDENT VALUATION" to encourage designs that shift peak load.
- (Reference the California Energy Commission website for more information)

ECONOMICS

Utility Rates:
Energy Charges
&
Demand Charges

How are you Now Charged for Electricity?

- Residentially-

  Energy (kW-h x $/ kW-h) = Total $$$

- Commercially-

Energy (kW-h x $/ kW-h) = $$$

Demand (Max. Monthly kW x $/kW) = $$$

Total = $$$$

- Commercially the “Demand” portion of your bill can be 50% of the bill!

Local Rates

- Energy charges (kW-h) – more expensive during peak times

- Demand charges: Typically from $5 per kW to $20 per kW

If demand is $7 per kW:

For every 100 kW shifted, the customer saves $700 per month in demand charges

Rightsizing

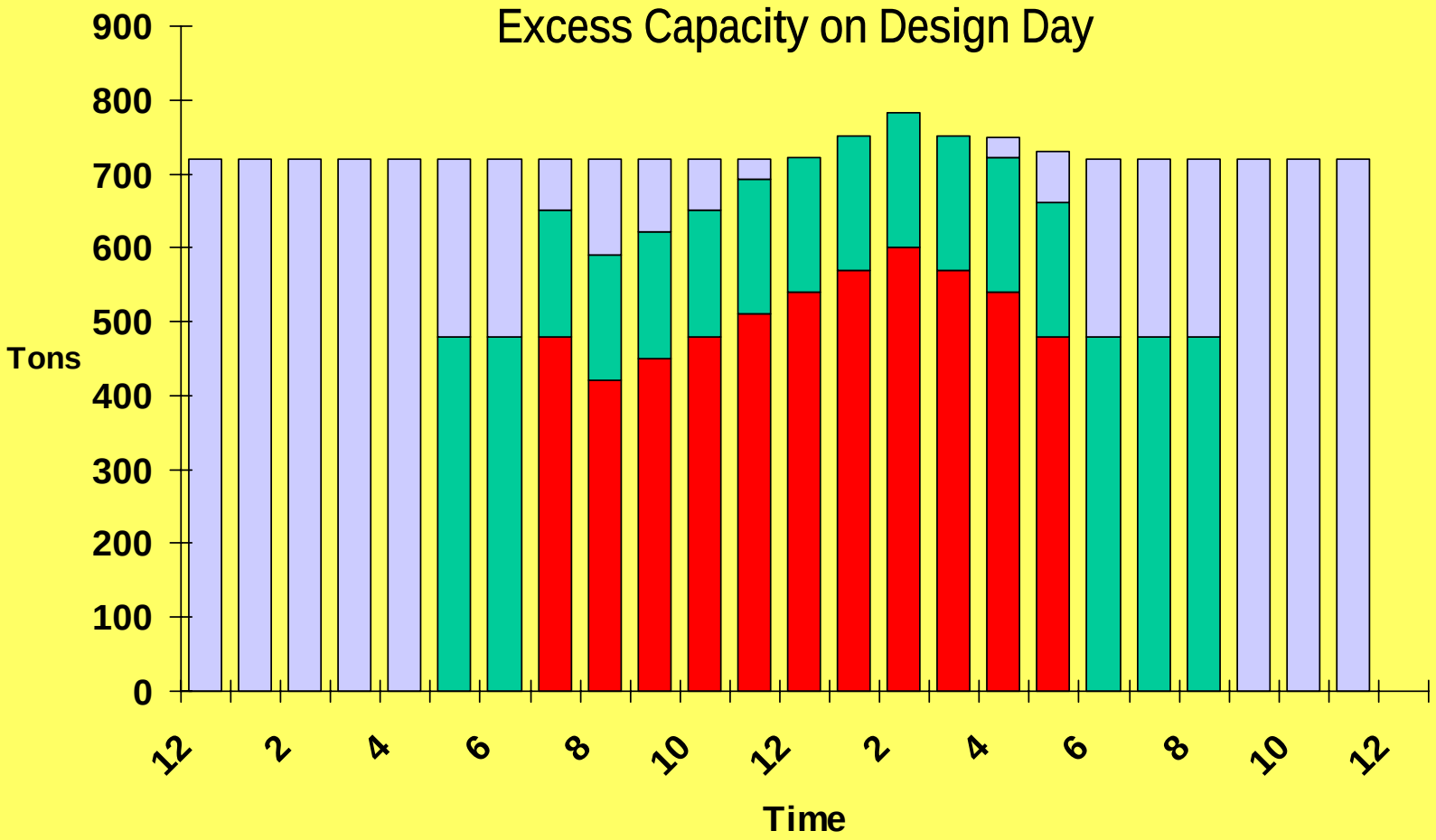
Instead of adding 20 % more refrigeration tons to a design for necessary safety factor, reduce refrigeration tons by 20% and add ice storage!

Conventional System (2) 360 ton chillers

Storage System Excess Capacity

Design Day Load

Storage System
(2)- 240 Ton Chillers
2,130 ton-hrs. Storage



Additional “Drivers” for Thermal Storage

- Power Supply Limitations
- Building Expansion/Increased Building Loads
- Chiller Cycling Issues
- Noise
- Federal Encouragement to Reduce Peak Loads
- Water usage issues

THERMAL STORAGE MYTHS

Thermal Storage:

- Is uncommon
- Is too expensive
- Lacks redundancy
- Is too difficult to control

Uncommon?

4.5 kW Heater

Over 6000 TES Installations Worldwide

Thermal Storage is Too Expensive

Typical Example:

500 Ton Peak Load

600 Ton Design to allow for safety factor and redundancy:

Non-Storage System 2-300 ton Chillers x $1,000/ton	=	$ 600,000
Partial Storage System 2-200 ton Chillers x $1050/ton	=	$ 420,000
1500 ton-hrs storage @ $150/ton-hr	=	$ 225,000
	=	$ 645,000

Thermal Storage Systems do not and should not be prohibitively expensive.

They are often installed at nearly the same cost as a conventional system.

Thermal Storage Lacks Redundancy

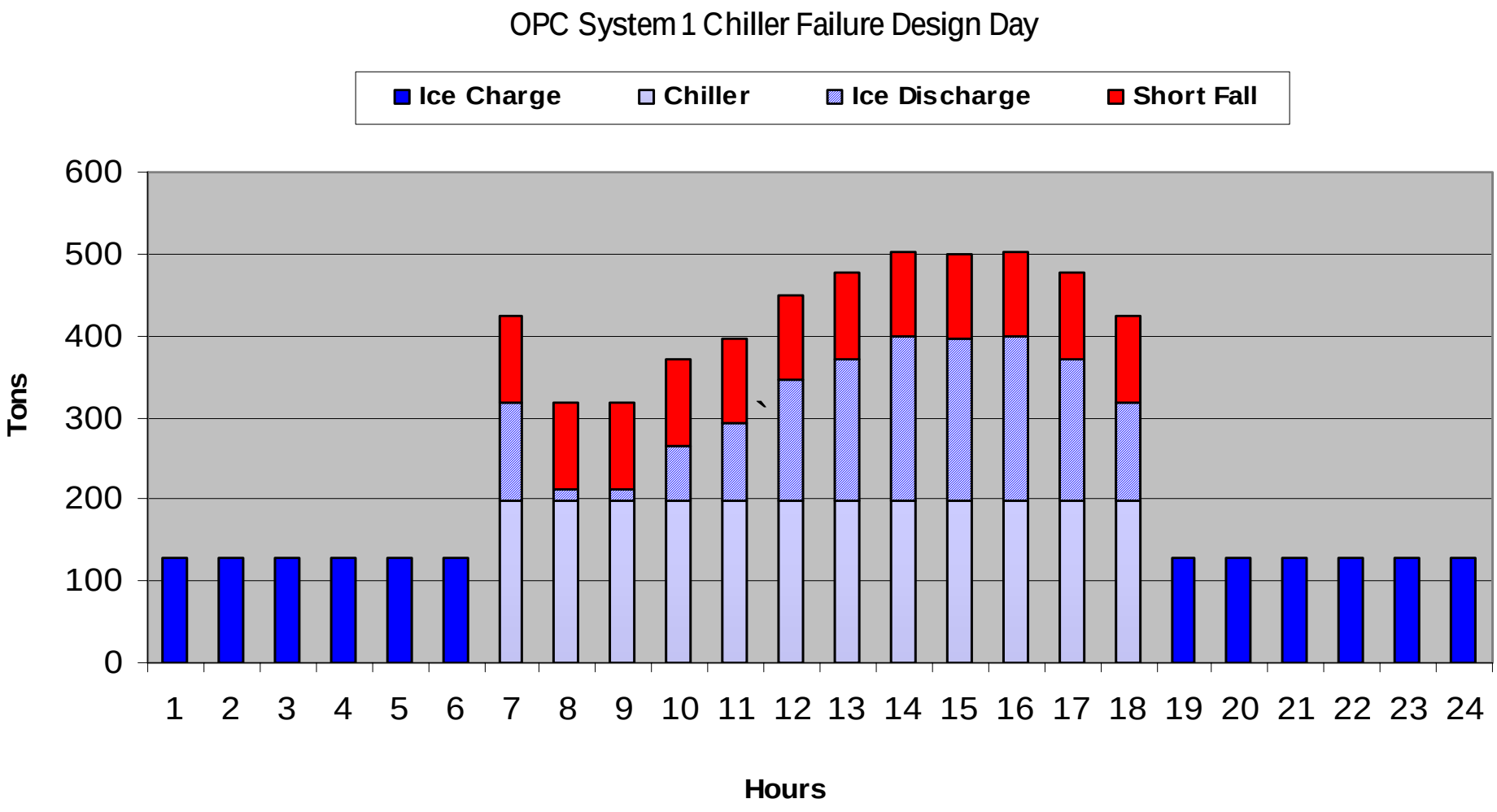
Consider the following 600 ton design:

- Two 300 ton chillers
- Two 200 ton chillers & Thermal storage

If one chiller goes down, which system will have more capacity? Which system provides more redundancy?

Apply redundancy and/or safety factors to thermal storage – COST EFFECTIVE REDUNCANCY

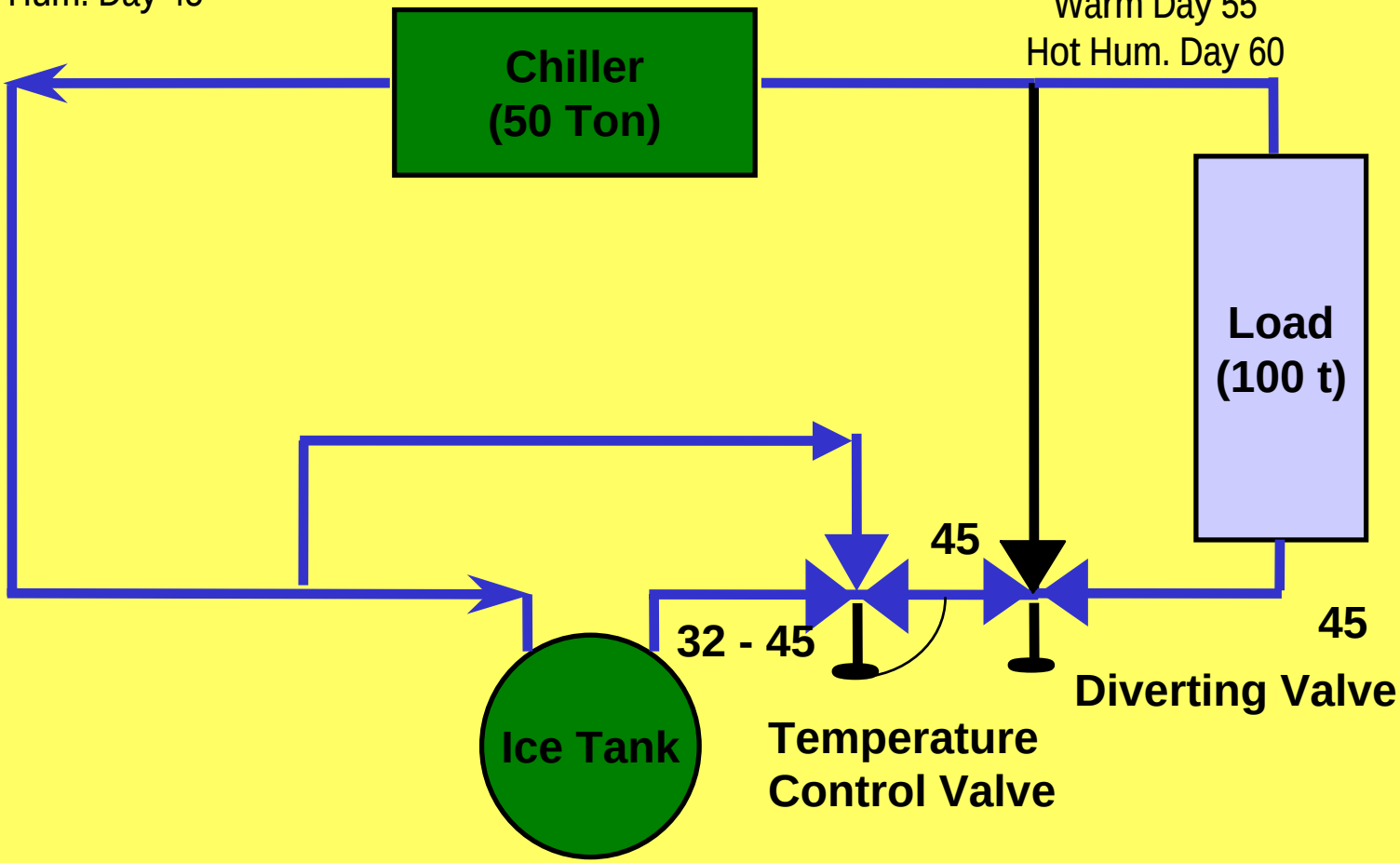
REDUNDANCY
THERMAL STORAGE vs. CONVENTIONAL SYSTEM



KEEP CONTROLS SIMPLE

Chiller LCWT Setting (Discharge)
Cool Day 55
Warm D ay 50
Hot Hum. Day 45

Return Temperature
Cool Day 55
Warm Day 55
Hot Hum. Day 60



ANY NEW INSTALLATIONS IN ARIZONA?

- THE UNIVERSITY OF ARIZONA IN TUCSON HAS JUST COMPLETED A NEW INSTALLATION TO COMPLIMENT THEIR GENERATION PLANT
- DOWNTOWN PHOENIX THERMAL STORAGE PLANT

University of Arizona
Self Generation and Ice Storage Plant

UNIVERSITY OF ARIZONA
http://www.fm.arizona.edu/

Combined Heat & Power Plant

Thermal Storage helps to:

- Increase plant cooling capacity
- Flatten the load curve
- Run the turbine more efficiently at night
- Stabilizes the day time loads on the chillers

(U of A will be giving tours of the facility)

SUMMARY

Thermal storage can:

- Be appropriate for many applications where there is a large differential between night and day time cooling loads.
- Help to avoid “over-sizing” chillers
- Can help achieve LEED certification.
- Should not be prohibitively expensive.
- Should have a relatively simple designs.

THANK YOU!

- ANY QUESTIONS??